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BIOCHEMISTRY.—*The biochemical analysis of nutrition.*[1]

CARL L. ALSBERG, Bureau of Chemistry.

There are a number of ways in which nutrition may be studied. By the statistical method the effect of diet upon definite social or geographical groups of individuals or upon inmates of hospitals, asylums, or barracks is determined. The physical method determines the energy income and outgo of the individual. The physiological method determines the rôle in nutrition of individual organs. Nutrition may, furthermore, be studied by the method of biochemical analysis. This method seeks to follow each one of the many chemical complexes that enter into the composition of food in its course through the animal organism. Therefore, for the purposes of this method the component chemical radicals of the food must be known. This information can be obtained only by resolving the food elements into their component parts, that is, by analyzing them biochemically. This paper, therefore, presents a discussion of some of the component parts of the food elements and of the fate in the metabolism of some of the individual chemical complexes that are found free or combined in food, in so far as their fate is understood or surmised.

My reason for selecting this particular subject is that during recent years perhaps the most interesting contributions to knowledge made by biochemists have been in this field. Among

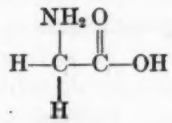
[1] The address of the retiring President of the Chemical Society of Washington, given at a joint meeting of that Society with the Washington Academy of Sciences, January 13, 1916.

the most important contributions of recent years to the study of nutrition are investigations upon the rôle of the proteins and of the nitrogenous constituents of the food in the animal organism. You know, no doubt, that in Liebig's time proteins were regarded as that element of the food which supplied the material for growth, tissue maintenance, and repair, as well as for most of the energy. Though it was soon demonstrated that while proteins did and could furnish energy, under ordinary conditions this was supplied in the main by sugar and other carbohydrates and by catabolized fats. The proteins were, however, still regarded as all of about equal value, and their value was estimated as proportional to the amount of nitrogen they supplied to the animal organism. One protein was regarded as of about as much dietary value as another. This was, however, soon found to be an erroneous notion. It was learned that with certain proteins, gelatine for example, as the sole source of nitrogen in the diet, life could not be supported. The proteins then came to be divided into two classes, the true proteins and the albuminoids. Gelatine was classed as an albuminoid. The fact that it and some other proteins were found to be incapable of supporting life was regarded as corroborative evidence that they were not true proteins. Why they are incapable of supporting life was not known. It was known that animals could not live without proteins in the diet, but it was believed that relatively few of the proteins were incapable of supplying all the nitrogenous needs of the animal organism.

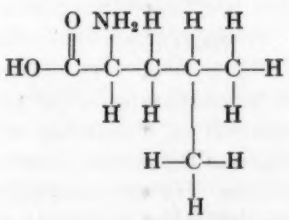
That is about where matters rested for a long time. Then in 1901 Loewi published a most startling investigation, so startling in fact that it received scant attention. He subjected the pancreatic gland, which all of you know as sweet-bread, to self-digestion, the process that is technically known as autolysis. As you know, practically all cells and tissues contain many enzymes or ferments, some of them similar to those secreted in the stomach and intestines for the purpose of digesting proteins. Therefore, under suitable conditions tissues can be made to digest themselves. Loewi caused the self-digestion of the pancreas to proceed until the digestion of the proteins in the gland

was so complete that no trace of any reaction for protein could be obtained. This predigested material as the sole nitrogenous element of the diet was then fed to dogs and it was found that upon such a diet the animals maintained their weight. These results were remarkable because they tended to show that it was not absolutely necessary to life that protein be an element of the diet. For a time these findings were ignored, but it has since been shown that life can be supported for a time at least upon a diet containing no complexes known as protein, but instead a suitable mixture of amino-acids.

For the information of those of you who have not followed the chemistry of the proteins during recent years I may say that the proteins are combinations of the amino-acids, by which we mean ordinary organic acids in which one or two hydrogen atoms have been replaced by the amino group, NH_2. The simplest amino-acid found in protein is glycine which, as you see, is derived from acetic acid.

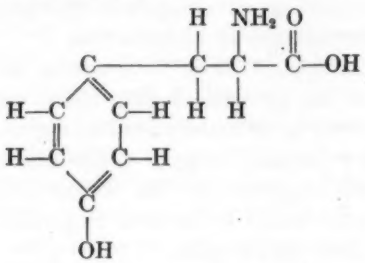


There are seventeen of these amino-acids commonly found in proteins. Several others have been reported more or less definitely. Perhaps the commonest one is leucine, which has six carbon atoms.

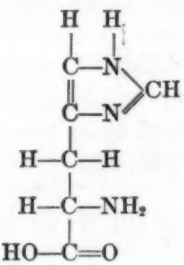


As you see, in all these substances the amino group is associated with the carbon atom adjacent to a carboxyl, COOH, group, the alpha position, as it is known technically. When two amino

groups are present one is in the alpha position; the other is associated with the terminal carbon atom at the other end of the chain, the omega position. Lysine is such a diamino-acid, as you can observe from the formula $CH_2(NH_2)(CH_2)_3 . CH(NH_2)COOH$. In these acids the atoms are arranged in a chain. However, the protein molecule may contain amino-acids in which the arrangement is such that a ring is found. Tyrosine, a benzol derivative, is a good example.

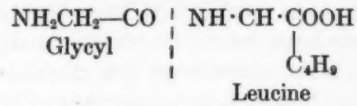


Histidine is another ring compound:



Tryptophane, which is related to indigo, is still another. The proteins are combinations of a number of these amino-acids with one another. Most of the seventeen or eighteen amino-acids are found in each protein. In all probability each molecule of protein contains a number of molecules of a given amino-acid, so that the protein molecule may be very large. The union of the amino-acids with one another is, so far as now known, always of the same kind; the amino group of one acid is united

with the carboyxl group of another. One of the simplest compounds of this type is glycylleucine:



Glycyl — Leucine

These compounds are known as peptides and were first made artificially. They were later discovered among the decomposition products of proteins. A peptide with a molecular weight of more than one thousand, composed of eighteen molecules of amino-acids, has been made. Substances with still larger molecular weights could be made, were it worth while. Thus substances which are believed to have a structure similar to that of proteins, and which have a molecule approaching in size that of some proteins, have actually been made.

After this digression in explanation of the chemical structure of proteins let us return to the problem of the nutrition of animals with amino-acids. Loewi found that animals could be kept for a time without loss in weight upon a mixture of completely digested protein. It was not at that time known that such mixtures contained peptides, which, as I have explained, have certain resemblances to proteins. It was therefore a most important discovery when it was later determined that an animal could be maintained for a time upon an artificial mixture of the pure crystalline seventeen or eighteen amino-acids found in proteins free from peptides. If these observations are correct, it is theoretically possible to supply the so-called protein needs of animals by wholly artificial substances.

Certain investigators have very recently gone still further by endeavoring to show that some of the nitrogenous needs of the animal organism can be supplied by simple salts of ammonia such as are used in fertilizers. It has hitherto been believed that only plants are capable of utilizing ammonia. The matter has not been settled; but there is good reason to believe, as will appear later, that even if it be shown that animals can utilize ammonia, it is impossible to support animal life upon ammonia as the sole source of nitrogen.

Whatever may be the ultimate practical significance of the observations that animals can supply themselves with most or all of their nitrogen needs by means of synthetic amino-acids, these experiments have led to investigations that have explained much that has been obscure in the physiology of nutrition. Formerly it was believed that proteins when ingested were digested by the enzymes of the intestinal tract and converted into simpler substances, in the main albumoses and peptones, which were absorbed. These albumoses and peptones, while simpler than most food proteins, are, nevertheless, still very complex substances. It was believed that they are absorbed and then converted by the animal into the protein characteristic of that particular animal. How that conversion was accomplished was not understood. Now every species of animal and plant has its own characteristic proteins. The proteins of even closely related species are different. The proteins of the food supply are quite different from those of the animal taking that food. Much work was done to explain how the proteins of the food were converted into the proteins of the body and where this conversion took place. At first it was believed to occur in the blood. Later a difference of opinion arose as to whether it took place in the tissues or in the intestinal wall. As food proteins could be demonstrated in neither place, the matter remained unsettled. We know today that neither hypothesis is tenable. Proteins are not ordinarily absorbed as such. They are completed dismembered within the intestinal canal into their component amino-acids and these are absorbed. As long as it was not known that an animal can be maintained upon pure synthetic amino-acids, no one had any reason to believe that proteins were completely digested before absorption.

Now what happens to these amino-acids after they are absorbed? As ordinary diets may contain more nitrogenous material than is needed by the organism, a part of the amino-acids is changed within the walls of the intestinal canal by the removal of the amino group to form ammonia. As this takes place in the presence of carbonic acid, ammonium carbonate and ammonium carbamate are formed. It has recently been

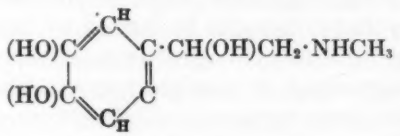
found that there is an equilibrium between these two substances, so that where one is present in solution there is also found a definite amount of the other. It is an easy step from ammonium carbamate to urea. Thus the amino group split off from the amino-acid in the intestinal wall or elsewhere is ultimately converted into urea and excreted. There are probably other methods of the formation of urea, as, for example, by cleavage from arginine which contains a guanidine grouping closely related to urea. After the removal of the amino group from the amino-acids there is left a carbonaceous residue which may be burned to furnish energy, perhaps directly, perhaps after conversion into sugar. A portion of the amino-acids absorbed by the intestines is not, however, deprived of its nitrogen, but passes into the blood stream from which it is absorbed by each individual cell according to that cell's particular needs. The cell then reconstructs from these amino-acids its own characteristic protein. Thus it is possible to explain in a comparatively simple manner how, for example, wheat protein when fed to an animal is converted into the characteristic proteins of that animal. It is done by the cells of the tissues from amino-acids supplied to the cells by the blood, the blood receiving the amino-acids from the intestinal wall.

This theory concerning the fate of food proteins in the animal body is supported by certain very interesting feeding experiments. In these experiments animals, usually white rats, were fed upon definite mixtures containing only a few pure food substances. These mixtures consisted of sugar, fat, mineral salts, and a single pure protein. In each set of experiments a different pure protein was used in each series, all other factors remaining constant. It is in this way possible to determine the nutritive value of individual proteins. The results of this work indicate that many proteins are incapable either of supporting life or of producing growth. On the whole it may be said that many more vegetables than animal proteins are defective in this way. Now, when the composition of such defective proteins is compared with that of proteins that are not defective in this respect, it is found that

the defective proteins lack one or more of the amino-acids which are found in the proteins that are not defective. This is very much oftener true for the vegetable proteins than for the animal proteins. Some lack lysine, others tryptophane or histidine, or cystine. The latter is an amino-acid containing sulphur, the usual form in which sulphur is contained in proteins. Some proteins lack more than one amino-acid. Gelatine, for example, contains no cystine, tyrosine, or tryptophane. Now it has been shown in certain cases that if to a diet of the kind just described, containing a single defective protein, there be added the amino-acids which that protein lacks, the value of the diet is greatly increased; in certain instances it may even become entirely capable of supporting life and growth. We have here a direct proof that the animal organism is capable of utilizing amino-acids and incapable of manufacturing for itself certain amino-acids. Herein it differs from the plant organism which is capable of making all the amino-acids necessary to support its life. The animal organism is, however, capable of making certain amino-acids. It can, for example, make glycine. It has not as yet been finally determined exactly which amino-acids can be made by animals and which can not.

There are a number of ways in which the lack of certain amino-acids may affect the functioning of the animal organism. Their lack may, of course, make it impossible for the animal to manufacture its own tissue protein. It suffers a kind of starvation. There are, however, more indirect ways in which the absence from the diet of a necessary amino-acid may be important. It has recently been found that the iodine compound of the thyroid gland, the gland that you feel in the neck about the Adam's apple, is a derivative of the amino-acid tryptophane. It has long been known that the normal functioning of the thyroid gland is essential to life and health. It has been found that the normally functioning gland contains the iodine compound now believed to be formed from tryptophane. It is therefore possible that when there is no tryptophane in the diet, difficulty in the formation of the iodine compound necessary for the thyroid gland results with corresponding disturbance of the gland's function.

The iodine compound of the thyroid gland is physiologically active; that is to say, it is poisonous. It is not, however, the only physiologically active substance produced from amino-acids in the animal metabolism. Adrenaline



is another such substance probably derived from an amino-acid. As you may see by comparing the formulae, it is related to the amino-acid tyrosine. It is formed in the adrenal glands, two small glands found in the kidney fat just above the kidneys. Hence their name, which was given to them before it was known that they have no direct relation to the kidneys. They apparently furnish adrenaline to the blood. Adrenaline when injected into the blood causes the small blood vessels to contract and therefore the blood pressure to rise, since the heart then pumps against the increased resistance of the contracted vessels. When the adrenal glands do not function normally, as for example when they are tuberculous, Addison's disease develops, which is characterized among other symptoms by a low blood pressure. The substance adrenaline is probably known to you, since it is used therapeutically in a number of ways, for instance, to constrict capillary blood vessels to stop bleeding from the capillaries on wound surfaces. If there is an absence from the diet of the material necessary to form adrenaline, it is conceivable that symptoms other than those of starvation might result.

There is a small gland at the base of the brain known as the pituitary gland, which is apparently necessary to life and which manufactures a physiologically active substance, probably derived from the amino-acid histidine. Disease of this gland seems to occur in certain giants and in the disease akromegaly, in which among other symptoms is found enlargement of the bones of the face and the extremities.

A very interesting physiologically active substance, para-

oxyphenylethylamine, is formed in the self-digestion of the pancreas from tyrosine, as shown by Emerson. It is tyrosine from which carbonic acid has been removed. This is of great interest, since it was at one time believed that carbonic acid was formed in living organisms solely by oxidation. This observation shows that it can also be formed by enzymatic cleavage. This is of profound biological interest, since in all probability the energy which is required by organisms living in an environment free from oxygen is obtained by reactions of this type. Ordinarily we think of such organisms as being limited to the fungi, but there are quite highly organized animals which live in this way; for example, parasitic intestinal worms. The gases of the intestines are practically free from oxygen. In all probability these worms obtain the energy necessary for the maintenance of life by cleavages, rather than by direct oxidation. Finally, it is interesting to note that most of these physiologically active substances are amines, probably derived from amino-acids by removal of carbonic acid, that is, by the elimination of the carboxyl, COOH. This method of the formation of amines is probably quite common in plants and leads to the formation of various poisonous plant bases. It has been suggested that the active principle of ergot is formed in this way.

In making this digression to explain that physiologically active substances may be formed from amino-acids, it was my purpose to suggest that the defective or incomplete proteins, when the main or sole nitrogenous element of the diet, may not merely produce a form of starvation, but that they may also have an indirect action through failure to supply the raw materials which are needed by certain glands to elaborate their specific products.

It should not be inferred from what has been said that these incomplete or defective proteins are without food value. On the contrary they may be of great food value. They are merely not of themselves sufficient, but they can be made sufficient if supplemented in relatively small amounts by other proteins that contain the lacking elements. This is a matter of the greatest practical importance in the feeding of farm animals.

Animal feeds consist in the main of vegetable proteins which are often incomplete. Obviously such a feed can be used most economically if it is supplemented by small amounts of proteins which supply the missing elements. To do this it is necessary to know what amino-acids are contained in the different vegetable foods. Agricultural chemists are now engaged in studying this problem. In this connection it must be pointed out that there is a distinction between maintenance and growth. It is perfectly possible to maintain an animal in good health upon a diet which will not permit it to grow. It is possible to stop the growth of an animal by putting it upon such a diet. When the diet is changed growth may be resumed. The capacity for growth has not been destroyed. Furthermore, it has been shown that it is not safe to conclude that a given diet is sufficient if it permits an animal to develop to adult life. It is necessary to show that it will also permit it to reproduce. There are diets that apparently permit perfect development but do not permit reproduction. It has also been found that more growth will take place upon a diet containing a mixture of incomplete proteins than upon a diet containing only one or two of them. Thus growing pigs will utilize for growth only about 24 per cent of the proteins of corn or wheat, whereas upon a mixture of the two grains they will utilize for growth about 33 per cent. It may be stated by way of comparison that pigs will utilize for growth about 60 per cent of the milk proteins fed.

Some of the investigators who put animals upon these restricted diets found that the animals throve a great deal better if small quantities of certain substances were added to the diet. The presence of so small a quantity of milk that its protein was a negligible factor kept animals growing or in good condition upon diets that would not otherwise permit the animals to remain in good health. A diet which does not permit normal growth will do so if a small quantity of butter is added. Apparently there are present in certain foods small quantities of substances of unknown nature which are necessary to growth and life. What this substance in butter is is not known. It seems to contain neither nitrogen nor phosphorus. This is

of importance, since it proves that the substance is not a lipoid. Lipoids are complex fat-like substances containing both nitrogen and phosphorus. It has been claimed that a diet without lipoids will not support life. The absence of nitrogen from the growth-promoting substance of butter indicates that it is not related to the vitamine of rice which is almost certainly a nitrogenous base. The vitamines are substances of unknown composition, found in certain foods and essential to life. In the polishing of rice the vitamine is removed. An individual living upon a diet of polished rice will develop a disease known as beri-beri, frequently found among rice eaters. There is apparently a whole series of substances found in foods which are necessary to life. The absence of certain of them is believed to produce scurvy. A similar hypothesis has been advanced concerning the disease pellagra.

Little is known as yet concerning the chemical nature of these substances. They are very unstable, being decomposed by heating, especially by sterilizing under pressure. Lime juice has been used for many years as an antiscorbutic. It is not particularly rich in these substances, but in lime juice they seem unusually stable. It has been suggested that the free organic acid present in the lime juice protects the antiscorbutic substances.

It is therefore quite evident that the last decade has brought forward many contributions of the greatest hygienic and economic importance. It is quite certain that more important discoveries are still to come. It is therefore well to look askance at popular prophecies concerning the approaching inadequacy of the world's food supply. When our viewpoint has changed so radically in a few years, it is idle to speculate about the future. If I have been able tonight to present this point to you clearly, I have accomplished my purpose.

PHYTOGEOGRAPHY.—*The eastern and the western migrations of Smilax into North America.* J. B. NORTON, Bureau of Plant Industry.

It is generally recognized by students of that group that Smilax and its allies must have spread over the earth from a point somewhere in southeastern Asia. This conclusion is borne out by several facts, particularly by the presence in that region of all the related genera with their subgenera, and by the breaking down there of certain group characters separating sections of the large genus Smilax, the last circumstance indicating a survival of the links that are often mourned as missing in other groups of organisms, but which are a source of trouble to a key maker when present. The evidence offered by paleontology likewise leads to the above conclusion.

In addition to these reasons for considering the region east of the Himalaya as the home of this group, the distribution of the species of Smilax in North America has a very distinct bearing on the question. *Smilax hispida* Michx. and *S. rotundifolia* L. are often confused by collectors, so closely do they resemble each other in some characters. *S. rotundifolia* and the related *S. Walteri* Chapm. have their nearest relatives in the Azores, the Canary Isles, the Mediterranean region, Asia Minor, Turkestan, and western India. This chain is broken in a few places from the complex group of spieces in northern India including *S. ferox* Wall., through *S. excelsa* L. and *S. canariensis* Willd. to *S. Walteri* and *S. rotundifolia* in America. The trail across the Atlantic is partly hidden, as the Bermudian species, *S. Bonanox* L., is apparently connected with the other European species, *S. aspera* L. But the relationship of *S. rotundifolia* to *S. excelsa* from the Azores is too striking to overlook. Throughout this group the stems have few large spines, which are never at the nodes. In *S. hispida* and its allies, on the other hand, the spines are slender and needle-like and numerous, at least below, where they often make a definite ring at the node. In *S. hispida* and its allies the berries are always greenish-black without a glaucous bloom, while in the *rotundifolia* group the berries are red or blue, with a distinct glaucous coat.

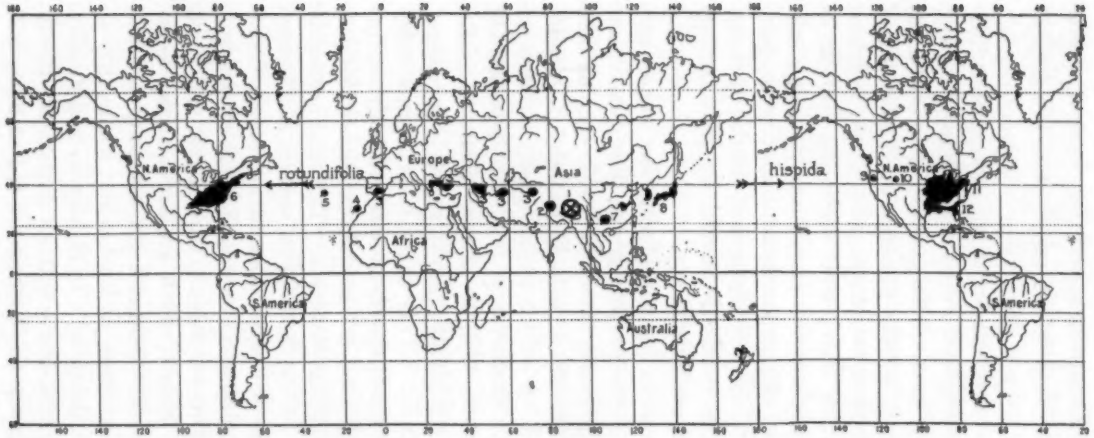


FIG. 1. Map showing the distribution of *Smilax rotundifolia* and *S. hispida*, with their allies, in relation to the supposed original home and distribution center of the genus at (1), in southeastern Asia; at (2), the region occupied by *S. ferox* and several other species which show a blending of group characters, but suggest a relationship to *S. rotundifolia;* at (3, 3, . . .), reported localities for *S. excelsa;* at (4) the related *S. canariensis*, which occurs on Teneriffe and in a varietal form extends to (5), the Azores, where also occurs a plant that is apparently true *S. excelsa*, while (6) shows the present distribution of *S. rotundifolia* in America. The eastern extension of Smilax, culminating in *S. hispida*, begins at (7), *S. scobinicaulis*, the south China species nearest the primitive type. In Japan and Korea, (8), is found *S. Sieboldi*, which shows a decided advance toward *S. hispida*. At (9) this group reappears in California and Oregon in *S. californica*, the nearest living relative of *S. hispida;* but a fossil form, *S. lamarensis*, which is apparently intermediate between its living American relatives, is found in Wyoming at (10). Finally, at (11) is indicated the region occupied by typical *S. hispida*, and at (12) that of its formal variety which splits away from the type in Texas and extends eastward in the coastal plain.

Smilax hispida has no European relatives but can, however, be traced back to India in another direction. *S. californica* Gray, a closely allied form, is found in a small area in northern California and southern Oregon, where it was apparently stranded when its connection with the rest of the world was destroyed by some disturbance in the past. The next species in point of relationship is *S. Sieboldi* Miq. of Japan and Korea. South of Korea we find no near relatives until we reach Yunnan, where *S. scobinicaulis* Wright fills in a space in the trail, both geographically and phylogenetically. *S. scobinicaulis* links up closely with the imaginary primitive types that can be constructed from the maze of inter-related species in the home area of the genus. In this migration we have a fine case of simple orthogenetic progression, with each successive step set off from the last by a barrier and with its nearest relatives in their proper places in the sequence.

Smilax herbacea L. and its relatives have followed the same path taken by *S. hispida* but have spread further, both in area and in differentiation of characters. While the other American groups have not left so plainly the tracks of their migrations from their Asiatic home, there can be little doubt that careful research will connect them all with the original stem.

The eastern and western migrations of Smilax have met and overlapped in the eastern United States, but it is probable that both waves are still moving. *S. hispida* has not as yet reached the Atlantic ocean, while *S. rotundifolia* is plainly stretching west through Texas to the Pacific. Eventually it is to be supposed that the waves will meet again in China. When this has occurred in any group the geologic record is necessary in tracing the course of the migration. In this connection it is interesting to note that the type of the fosssil *S. lamarensis* Knowlton, from the Yellowstone, has been examined and found to show an undoubted intermediacy between *S. californica* and *S. hispida*. To complete the geographic trail it is only necessary to find a fossil form from the North Pacific coast. In the accompanying chart (fig. 1), based on Mercator's projection of the globe, the longitudinal separation of the successive steps in the northern zones is greatly exaggerated.

BOTANY.—*Agriculture and native vegetation in Peru.* O. F. Cook, Bureau of Plant Industry.

Alternation of forests with open grass lands or sparse desert vegetation is one of the most striking of the biological phenomena of tropical countries. Since the time of Humboldt many travelers in tropical America have sought to explain the presence or absence of the different types of vegetation by reference to differences of geological formations, altitudes, prevailing winds, or other natural features. More recent observations in Central America have led to the opinion that the chief factors governing the distribution of the forest vegetation are the agricultural occupation of the land and the continued action of fire on lands abandoned from cultivation.

There are reasons for believing that most of the forests of Central America do not represent original or virgin growth, but different stages of reforestation. Likewise most of the open grass lands and deserts appear to be consequences of the native system of farming—to be interpreted as artificial conditions rather than as natural features. The climatic, geologic, or topographic factors, though not without influence in determining the rate of reforestration, seem in general to have very little importance in comparison with human activities and exposure to fire. The complete reforestation of fireswept grass lands is a long and gradual process, but the successive stages can be recognized by taking account of the habits of the different kinds of trees.[1]

Opportunities of studying the relations of agriculture to forest vegetation under a different combination of natural conditions have been afforded during four months (April to July, 1915) spent in southern Peru and Bolivia as a member of the Expedition conducted by Professor Hiram Bingham, under the auspices of Yale University and the National Geographic Society, with the cooperation of the United States Department of Agriculture. Most of the time was spent in the region traversed by the Urubamba River and its tributaries, from the Pass of

[1] Cook, O. F. Vegetation Affected by Agriculture in Central America. Bull. 145, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1909.

La Raya, at an elevation of 14,000 feet, down to Santa Ana, at an elevation of 3000 feet, including a visit to the Panticalla Pass and the Lucumayo Valley. The region includes Cuzco, Pisac, Ollantaytambo, and Machu Picchu, the chief centers of the Inca and pre-Inca or Megalithic civilizations, and is of great agricultural and ethnological interest as the original home or place of domestication of numerous species of cultivated plants.

In this part of Peru, as in Central America, it apears that the present distribution of the principal types of vegetation is not a natural effect of altitudes, climates, or soils, but an artificial result of an intensive agricultural occupation of the land, extending through a long period of time. If we wish to think of an original condition, a biological background, so to speak, of the primitive agricultural civilization that occupied this region, we must imagine a country well covered with forests. The destruction of forests appears to have been carried much further than in Central America, in many localities to the complete extermination of all forms of arboreal vegetation. The chief considerations that seem to support these conclusions are stated in the following paragraphs.

BIOLOGICAL CONDITIONS FAVORABLE TO FOREST GROWTH

Though many districts are now entirely treeless and true forests are found in only a few localities, there appear to be no natural conditions that are definitely unfavorable to arboreal vegetation. Light, heat, and moisture are sufficient to support the growth of trees and there is ample fertility of soil, at the higher elevations as well as in the lower and more tropical valleys. In other words, there seems to be no climatic or biological factor to preclude the growth of trees on any part of the land surface except the bare rocks and snow fields at the summits of the high cordilleras.

From the positions of the moraine deposits and the lack of soil accumulations above them it may be inferred that the glaciers have receded in comparatively recent times, perhaps following the destruction of the forests. Some of the moraines

FIG. 1. Native agriculture in a branch of the Ushcopata Valley above Sicuani, Peru, at an altitude of nearly 13,000 feet, with fields of potatoes, barley, and broad beans, and remnants of the native forest flora—the white trees *quishuar*, the others mostly *queñuar* and *capuli*.

are as low as 9000 feet, with the present glaciers ending from 2000 to 4000 feet above. Under the Peruvian conditions it does not seem unreasonable to believe that the removal of a forest covering might tend to bring about a recession of the glaciers. Greater exposure of the rocky slopes would bring increased heat and dryness of atmosphere. Less snow would fall and the accumulations on the high summits would be exposed to longer periods of melting under direct sunlight.

As trees are often found above the moraines, there is no reason to doubt that the ancient forest covering extended up to the glaciers, as forests are known to do in other glacial regions. Several isolated tracts of forests have been found by Professor Bingham at very high elevations, even up to 15,000 feet. These high-altitude forests are of interest as affording the most definite demonstration of the fact that tree growth is not limited by elevation alone.

ANDINE FOREST FLORA

The possibility of a forest covering for all of the inhabited areas of this region is shown not only by the fact that trees grow when planted, but also by the presence of an indigenous forest flora whose different components are well adapted to the various natural conditions afforded by different exposures and elevations, up to the line of glaciers.

Two of the high-altitude trees, *queñuar* (Polylepis) and *quisuar* (Buddleia), have been noted frequently by travelers because they are often planted in villages or allowed to grow among the fields. (See fig. 1) Other members of the Andine forest flora of southern Peru are *lambran* (Alnus), *chachacoma* (Escallonia), *unca* (Eugenia), *lengli* (Hesperomeles), *quisca* (Berberis), *mulli* (Schinus), *chicjlluromay* (Vallea), and numerous other trees, including various arboreal Compositae. Several of the genera are represented by two or more species. Some of these, such as the species of Escallonia, are reported by botanical writers only as shrubs, but under favorable conditions they attain true arboreal proportions, especially at altitudes of 10,000 to 12,000 feet.

REFORESTATION OF TERRACED VALLEYS

Though no original or virgin forests are now known to exist in this part of Peru on any lands that could be cultivated, reforestation with native trees is in progress in many places, notably in the valley above Ollantaytambo, and in the next valley to the west, leading up to the Panticalla Pass. In both valleys the growth of the native trees has progressed so far that

FIG. 2. Valley above Ollantaytambo, Peru, at an altitude of about 10,000 feet, showing terraced slopes partly overgrown with forests of native trees, including *quishuar*, *queñuar*, *lambran*, *unca*, and *lengli*.

genuine forest conditions have been restored, in the Ollantaytambo Valley covering several hundred acres, in the Panticalla Valley thousands of acres. Reforestation is demonstrated by the fact that the trees stand on ancient agricultural terraces supported by skilfully constructed stone walls. (See fig. 2.)

The survival of native trees in these valleys may be ascribed to the presence of lateral ravines too deep, narrow, and precipitous for cultivation. Such places may well have escaped the other-

wise complete clearing of the land for agricultural purposes. Hardy types of woody vegetation, growing in the ravines and on the rocky slopes above, might survive even long perods of agricultural occupation of the terraced lands below. The neighboring areas might be seeded easily from the old trees. Such a ravine, leading up from the other side of the spur shown in the figure, is now heavily wooded and contains many well matured trees of the same species that now cover the terraces, although very few of the trees appear to be very old or to have reached the stage of natural decay. Some of the terraces in the Panticalla Valley are covered with much older trees than any found in the valley above Ollantaytambo.

HABITS OF SURVIVING NATIVE TREES

Although the genera of native trees, as mentioned above, belong to as many different families, there is a general similarity in habits of growth, in that all of them sprout readily from the stumps and endure repeated cutting. Seed is produced in a few years, if the sprouts are allowed to grow. The limitation of the present forests to such trees may be taken to indicate that persistent vitality was necessary to pass through the periods when these valleys were occupied by large agricultural populations, as shown by the extensive terracing of the slopes. A period of complete denudation of a valley would mean the extermination of all kinds of trees that were unable to sprout from the stumps, but trees like Escallonia, Eugenia, and Schinus might survive centuries of pollarding. The last is familiar as the "pepper-tree," now grown by thousands in southern California for shade and ornamental purposes. Other members of the Andine tree flora are even more attractive in appearance and promising for introduction into the United States.

DENUDATION OF UNCULTIVATED LANDS

The former presence of large agricultural populations accounts not only for the clearing of all the lands that could be cultivated, but also for the denudation of lands that were not capable of

cultivation. The growth of each native community means that supplies of fire-wood have to be sought farther and farther away. A large Indian town is usually surrounded by a broad belt of denuded lands, no forest being allowed to remain within two or three leagues. Judging the past by the present, a period of denudation of all the neighboring slopes must have followed the building of the extensive systems of terraces in the valleys about Ollantaytambo, Torontoy, and Machu Picchu. The country around these centers must have reached the same treeless state as the districts that now have large agricultural populations, such as the Vilcanota Valley and the slopes around Lake Titicaca.

REFORESTATION PREVENTED BY FIRE

In many localities cultivation is confined to the bottoms of the valleys or to the lower slopes, while the higher slopes have only a sparse covering of grass or low bushes. This gives the impression that the interior of the country is naturally treeless, like the desert regions along the coast. But the coast deserts are explained by the rainless climate, whereas in the interior the rainfall is sufficient to support forest growth.

The former cultivation of many of the higher slopes is indicated by the ridges and terraces that still remain. These show in turn the previous existence of forests, since forests must have preceded cultivation in order to accumulate soil and make it possible to clear the land by the primitive method of burning. This method is ineffective on grass lands, which have to be reforested before they can be re-occupied by a primitive agricultural people. At the higher altitudes grassy slopes are cultivated by spading, but this method is used only where turf is formed.

When treeless slopes are seen in tropical valleys meeting the tropical forest vegetation, it is plain that some active enemy of forest growth must be at hand, and this is fire. The fires that are set to clear land for cultivation commonly escape and overrun the slopes above. As the grass-covered slopes are used only for grazing, no effort is made to protect them from fire.

FORESTS IN INACCESSIBLE PLACES

Trees are often found growing under very unfavorable natural conditions, in places that are too steep, rocky, or isolated to be cleared for cultivation or for providing fuel. In the lower Urubamba Valley it was observed that the driest and rockiest hillsides in the vicinity of Santa Ana are covered with forests of *huillca* (Piptadenia) and other tropical trees, while the smoother and more fertile lands on either side have no trees, but a heavier growth of grass.

Tree seedlings often appear in grass lands, but are killed when fires sweep over them. Hence, the forests are confined to the rocky slopes as long as the adjacent grass lands are visited by fire. Grazing reduces the danger of fire, and this assists in reforestation; but the forests themselves may burn after sufficiently long periods of drought. In the lower Urubamba Valley, at altitudes of from 4000 to 8000 feet, the forests have been burned on many slopes altogether too steep for cultivation. This not only kills the trees but often has the effect of loosening the soil and rocks, causing destructive landslides.

PAUCITY OF THE HUMUS FAUNA

Another indication of the more complete denudation of this region in former times is the paucity of the humus fauna, comprising the insects, millipeds, centipeds, and other small animals that live normally in the upper layers of the soil. These creatures become very abundant under conditions that afford permanent moisture in the soil, but are killed when the land is burned over or parched by severe drought. In southern Peru the humus-inhabiting animals are everywhere extremely scarce, and often lacking altogether. The number of species is very small, as well as the number of individuals. Of millipeds only three orders are represented, Merocheta, Anocheta, and Diplocheta; in many localities only Merocheta, and most of these of Antarctic types rather than tropical. The three orders of very primitive arthropods, Symphyla, Rhabdura, and Dicellura, are present, but were nowhere found in abundance, even in places

where reforestation has advanced so far that ample deposits of humus have accumulated. Humus-inhabiting insects of other orders, including the Thysanura and Collembola, are also few.

ABSENCE OF PALMS IN TROPICAL FORESTS

The flora of the valley between San Miguel at 6000 feet and Santa Ana at 3000 feet is distinctly tropical, and large areas are forested, but not with original or virgin growth. That reforestation is still far from complete is shown by the general scarcity and often complete absence of palms. Instead of a normal palm flora, no locality in the Urubamba Valley was found to have more than two species, a large Geonoma and a small Chamaedorea.

This deficiency seems the more significant because the natural conditions are extremely favorable and the palm flora of the adjacent regions of South America is one of the richest in the world. The original palm flora of this district can not be estimated at less than a dozen species, and may have included two or three times that number. But denudation would involve a complete extermination of the palms, and these plants are very slow to return, even after forest conditions have been reestablished.

RECONSTRUCTION OF THE FLORA AND FAUNA

In view of these indications of prolonged interference with the original conditions of plant and animal life it does not seem reasonable to ascribe the present distribution of the native vegetation entirely to differences of soil, temperature, altitude, or rainfall. An ecological account of the Peruvian flora that ignores the factor of human activity, as in the treatise by Weberbauer, does not convince. To present an adequate conception of the native flora and its relations with the external conditions would require a process of reconstruction, a careful collecting and piecing together of the parts of the flora and fauna that are left. Then there would need to be a careful comparison with the floras and faunas of neighboring regions that were not occupied and denuded by the ancient civilizations, if such regions can be found. This would give a better appreciation of

the extent to which the presence of man has modified the original conditions of the environment along the eastern slopes of the Andes.

AGRICULTURE AT HIGH ALTITUDES

Corresponding with the wide range of altitude there is great diversity in the forms and habits of the wild vegetation and in the agricultural arts of the native inhabitants. In the lower valleys where corn is the principal crop the method of clearing the land and the relation of agriculture to the native vegetation are much as in Central America.

The high plateaus of Peru, where the native agricultural population is now chiefly centered, are unlike any part of Central America, the nearest approach being found in the tablelands of Guatemala. In Central America cultivation is hardly carried above 8000 feet; whereas in Peru potatoes and other Andine crops are commonly grown at 13,000 feet and in some places at 14,000 feet. Moreover, it is in these elevated districts that the native system of agriculture attained its highest development and was least disturbed by the Spanish conquest.

CONCLUSIONS

The native agriculture of southern Peru is self-limiting. Cultivation may be maintained for longer periods on the tablelands and higher slopes, but when the soil is once exhausted and removed by erosion there is less prospect of renewal through reforestation than at the lower elevations. Although under the high altitude conditions the accumulation of soil goes on to a certain extent in open grass lands, without the aid of forests, such gains evidently do not make good the losses incidental to cultivation. Large areas of the higher slopes that appear to have been cultivated intensively in former times are now completely sterile and abandoned.

Thus Peru may be said to afford even more striking evidence than Central America of the fact that the primitive agricultural civilizations were not permanent, but of limited duration. Eventually the soil became unsuited to cultivation by the native methods.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Lavas of Hawaii and their relations.* WHITMAN CROSS. U. S. Geological Survey Professional Paper No. 88. Pp. 93, 4 plates. 1915.

The Hawaiian Islands have been built up by a long continued series of volcanic eruptions beginning at a point far west of the principal islands of today. While basalt of a common type is the predominant rock of the islands, there is much greater variety among the rocks than has heretofore been recognized. As indicated by the work of Cohen, E. S. Dana, Lyons, and Silvestri, the rocks range chiefly between normal basalts rich in olivine, augite, and highly calcic plagioclase to pyroxene andesites either free from or poor in olivine and containing andesine or more richly sodic plagioclase. There are, however, more basic rocks such as limburgite, nephelite and melilite basalt, and picritic basalt, while xenoliths of peridotite are reported from several islands. A soda trachyte is the most feldspathic rock so far collected.

The chemical characters are discussed on the basis of 43 existing analyses showing many rocks of the so-called alkaline type. These analyses evidently do not cover the entire range of rock types but, classifying the analyzed rocks in the "quantitative system," all but the three most salic rocks come within the range of two classes, that is, in Class III or the adjacent halves of Classes II and IV.

The Hawaiian archipelago forms a simple petrographic province whose rocks are clearly comagmatic and consanguineous. The region is especially suited to furnish the means of testing several broad generalizations of the day regarding the genetic relations of igneous rocks.

Each of the larger islands contains several kinds of rocks showing important differences in both chemical and mineral composition and conversely several kinds of rocks are known in all or nearly all the larger islands. In view of the meagerness of our knowledge concerning

all the centers of eruption it is believed that nearly all the varieties described and perhaps some others occur on each of the principal islands. Nephelite-melilite basalts are known on three islands—Kauai, Oahu, and Maui. Strongly feldspathic andesites occur on Hawaii; and the lavas of Kilauea, the youngest volcano of the islands, are predominantly olivine-poor basalts.

The relations of the magmas as differentiation products are compared with those of other island groups of the Pacific Ocean, and the distribution of the Hawaiian types in other parts of the world is considered. Their chemical characters and the circumstances of their association demonstrate that the so-called alkalic and calcic magmas may and do occur together as derivatives from a common source. The current generalization that this distinction between alkalic and calcic series ("Atlantic and Pacific branches") of igneous rocks is of fundamental importance in petrogenesis and may serve as a factor in a natural system of classification is held to be fallacious and to lead to endless confusion.

The series of Hawaiian lavas are concluded to have been derived from a general magma of nearly the same character in all parts of the province. It does not seem probable that there has been any noteworthy differentiation in the main reservoir beneath the Hawaiian district. During the active growth of each volcano the lavas presented a moderate variability in composition, but definite system in this variation was not detected. With decreasing eruptive activity and possibly attendant contraction and limitation of lava chambers a higher degree of differentiation was accomplished and is shown by more salic and correspondingly more femic lavas than those of earlier date. In the long period of parasitic or subsidiary eruptions conditions were favorable to extensive differentiation. The processes of differentiation are still problems for investigation. Movement under gravity of crystal particles may have played a part. J. FRED. HUNTER.

BOTANY.—*On the characters and relationships of the genus Monopteryx Spruce.* HENRY PITTIER. Bulletin of the Torrey Botanical Club, **42**: 623–627. 1915.

The genus Monopteryx (Fabaceae) was based upon flowering specimens of a tree collected by Spruce on the upper Río Negro, Brazil. Because of the fact that the fruits were unknown, the genus has been erroneously placed among the Sophoreae. Complete specimens of a new Venezuelan species, *Monopteryx jahnii*, show that the genus is closely related to Pterocarpus. H. P.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE WASHINGTON ACADEMY OF SCIENCES

The 107th meeting of the Washington Academy of Sciences was held in the auditorium of the New National Museum at 4.45 p.m., April 7, 1916, with President L. O. HOWARD in the chair and a large audience present. Dr. EUGENE F. DUBOIS, Medical Director of the Russel Sage institute of Pathology, New York, gave an illustrated lecture on *The basal food requirement of man.*

The lecture dealt chiefly with the amount of heat generated by the body as affected by such factors as age, sex, size, labor, and disease. It was shown that the metabolism, or sum-total of chemical changes within the body, as manifested by the quantity of heat generated per unit area of surface, is very low in the infant, rises to a maximum (1.5 that of the adult) at the age of 4 to 6 years, and then falls rapidly to the metabolism of the normal adult, except at the age of puberty when it rises slightly. From 20 to 30 it remains constant, after which it slowly decreases.

Metabolism is somewhat greater in man than woman, increases practically in direct proportion to the total skin area, varies enormously—even more than 5 fold—with different degrees of exertion, and in disease varies widely with the nature of the malady. In typhoid, for instance it is roughly 50 per cent greater than in health, demonstrating that the typhoid patient needs to be *fed*, rather than starved. Equally interesting and valuable results have been gained from the studies of other diseases, so that scientific human feeding may soon be expected, at least in hospitals.

The 108th meeting of the Academy was held in the auditorium of the New National Museum, Friday afternoon, April 14, 1916, with Dr. CARL L. ALSBERG in the chair and a large audience present. Dr. GRAHAM LUSK, Professor of Physiology, Cornell Medical College, gave an illustrated lecture on *Nutrition and food economics.*

An extremely interesting exhibit was shown of different kinds of food,—hominy, oat meal, rice, flour, potatoes, etc.—each sufficient in amount for an adult, if inactive, for 24 hours. At present prices the cheapest food appears to be corn meal, or hominy, costing, if one lived on this alone, about 4½ cts. per day. Tables were shown that gave the quantities and the costs of many kinds of food, assuming one to live on each alone. Hominy, oat meal, and rice are the cheapest, while of

ordinary foods meat is the most expensive. Other tables were presented that gave the actual quantities and kinds of food used at certain schools, some of which strikingly confirmed the general belief that one eats more during his "teens" that at any other time of life.

The 109th meeting of the Academy was held in the Auditorium of the New National Museum, Friday afternoon, April 21, 1916, with President L. O. HOWARD in the chair and an appreciative audience present. Dr. E. B. FORBES, Chief of the Department of Nutrition of the Ohio Agricultural Experiment Station, gave an illustrated lecture on *Investigations in the mineral metabolism of animals.*

Careful investigations, especially with cattle and hogs, have shown the importance of having sufficient amounts of certain mineral substances in their food. Of these calcium in some assimilable form is needed in greatest abundance, particularly during the period of rapid growth. Hence blue grass, which is rich in calcium salts, is an excellent food for growing stock, while an all-grain food, poor in such substances, is inadequate. Among the interesting developments of the work was the fact that good milch cows secrete more mineral matter during the period of full lactation than they assimilate from even the best food, and thereby suffer a kind of mineral exhaustion.

The 110th meeting of the Academy was held jointly with the Geological Society of Washington in the lecture room of the Cosmos Club, Wednesday evening, April 26, 1916, with Dr. A. C. SPENCER presiding and about 60 persons present.

Dr. K. F. KELLERMAN spoke of *Bacteria as agents in the precipitation of calcium carbonate.* Illustrations were shown of spherulites formed through bacterial agency from solutions of calcium sulphate, calcium acetate, and artificial sea water, which are practically indistinguishable from those formed in nature.

Dr. J. JOHNSTON discussed *Some factors which influence the deposition of calcium carbonate.* The fundamental importance of the solubility-product in relation to saturation was explained, and the different methods of producing precipitation or inducing solution discussed. The greater solubility of calcium carbonate in cold water obviously must lead to its depletion in the higher latitudes and its accumulation in equatorial regions, a process which appears to be in full operation.

Dr. H. E. MERWIN described *The forms of calcium carbonate and their occurrence.* There are at least three easily distinguishable crystallized forms of calcium carbonate and a number of doubtful forms. The form deposited from a solution depends very largely upon temperature, though there may also be other contributing causes.

In the discussion that followed Dr. T. WAYLAND VAUGHAN spoke of the oölitic deposits of Florida and their problems, and Dr. CHAS. D. WALCOTT described the similar silicious deposits of the Yellowstone Park.

The 111th meeting of the Academy was held in the Auditorium of the New National Museum, Friday afternoon April 28, 1916, with President L. O. HOWARD in the chair and about 200 persons present. Dr. CARL VOEGTLIN, of the U. S. Public Health Service, Washington, D. C., gave an illustrated lecture on *The relation of the vitamines to nutrition in health and disease.* It formerly was supposed that any diet was sufficient if it contained enough proteins, fats, carbohydrates, and salts; but it is now known that under certain circumstances, even with an abundance of food, nutrition diseases such as scurvy and beri-beri are apt to develop. Beri-beri, for instance, is likely to develop when polished rice forms the exclusive diet, but does not occur when the rice is unpolished and even disappears when the patient is given rice-bran or certain bran extracts. It follows that the bran contains something essential to health which the rice-grain proper does not. Such products are found in many grains and plants and are known as vitamines, that is, basic organic compounds essential to life. These compounds are produced by plants only, but very unequally. In the animal body they are found most abundantly in the spinal cord and other nerve tissue.

W. J. HUMPHREYS, *Recording Secretary.*

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 770th meeting was held on March 18, 1916, at the Cosmos Club; President BRIGGS in the chair, 46 persons present. The minutes of the 768th and 769th meetings were read in abstract and approved. The Secretary reported the action of the General Committee adopting an amendment to Article V of the By-laws to class as life members all who have maintained an active membership in the Society for 40 years. Messrs. ABBE, CLARKE, DALL, and GILBERT have been designated life members under this amendment. The treasurer read a communication from the Secretary General of the Committee of the International Association of Academies in charge of the publication of the *Annual Tables of Constants and Numerical Data* expressing thanks for the continued financial aid received from the Society.

Mr. H. C. DICKINSON presented an illustrated communication giving the results of an investigation in collaboration with Mr. M. S. VAN DUSEN on *Heat transmission through air layers.* Measurements were made of the heat transmission in unit time per unit area and unit temperature difference through vertical air layers inclosed between plane nickel-plated copper plates, for heights (h) of from 3 to 60 cm., for distances (D) between the plates of from 1 to 60 mm., and for differences of temperature (Δ) of from 5° to 30° centigrade. The effect of direct radiation was determined and all observations were corrected to include only transmission due to gas conduction, quiet convection, and turbulent convection. Transmission decreases to a minimum for increasing D and for greater widths becomes nearly constant, the position of minimum depending upon h. Transmission decreases with increasing

h, and increases with increasing Δ. Applications of the results to calorimetric problems in the laboratory as well as to many industrial problems were suggested. An approximate mathematical expression for the results obtained was presented.

By invitation Mr. L. H. ADAMS presented an illustrated paper on *The thermoelectric power of pure metals*. Thermoelectric force and the closely allied thermal and electrical effects have an important bearing on many aspects of the behavior of metals and an extended knowledge of these quantities would go far toward a solution of the problems of metallic conduction. The results enable one to calculate 4 other quantities, viz. $\frac{dE}{dT}$, $\frac{d^2E}{dT^2}$, Peltier effect, and Thomson effect. The last named, although extremely difficult to measure calorimetrically, can be determined by the electrical method with considerable accuracy. Curves illustrating the course of $\frac{dE}{dT}$ and of the Thomson effect from absolute zero to very high temperatures show that the relations involved are much more complicated than has hitherto been supposed, and explain the difficulty of obtaining a suitable equation for representing the thermoelectric force as a function of the temperature. It is of interest to note the extraordinary sensitiveness of the thermoelectric force to slight impurities in the metal.

The communication was discussed by Messrs. SWANN, BURGESS, and WHITE. The Chair expressed to the speaker the Society's thanks for his very suggestive paper.

Mr. A. HALL then spoke on *The equatorial micrometers of the Naval Observatory*, illustrating his communication with lantern slides. The micrometers constructed by Clark, Saegmüller, Warner and Swasey, and Repsold were compared. The last is a large instrument, made of iron and steel, with a platinum-iridium position circle, purchased by the Naval Observatory in 1913. An eye-piece microscope is provided for the examination on the telescope of the micrometer screw. The readings of the screw can be made in the usual manner or can be printed on a Morse fillet, on two type-metal wheels which carry raised figures. Great care is taken to have the illumination of the threads symmetrical, and in every way provision is made to eliminate systematic errors.

The Secretary read an invitation from the Washington Academy of Sciences inviting members of the Society to attend a lecture by Dr. L. H. BAEKELAND at the New National Museum on March 23 at 8.30 p.m.

The 771st meeting was held on April 1, 1916, at the Cosmos Club; President BRIGGS in the chair, 44 persons present. The minutes of the 770th meeting were read in abstract and approved.

Mr. R. S. WOODWARD presented a communication on *The extraction of square roots of numbers*. Referring to a previous communication to the Society by the author on the same subject some further applications were explained of the formula

$$\sqrt{m} = \sqrt{(a\,b)} = \tfrac{1}{2}(a+b)\left\{1 - \frac{(a-b)^2}{(a+b)^2}\right\}^{\frac{1}{2}} \quad \ldots\ldots (1)$$

In this m is any number and a and b are any two numbers whose product is m. Attention was called to the rapid approximation which may be secured by successive applications of the arithmetic mean $\frac{1}{2}(a+b)$. Special emphasis was given to the use of formula (1) when m is an integer and not a square. In this case the square root of m is involved in the two equations

$$y^2 - mx^2 = \mu$$
$$y^2 + mx^2 = \nu$$

in which every symbol represents an integer. These equations give[1]

$$\sqrt{m} = \frac{\nu}{2\,x\,y} - \frac{\mu^2}{4\,x\,y\,\nu} - \frac{\mu^4}{16\,xy\nu^3} - \quad \ldots\ldots (2)$$

The number μ is arbitrary within certain limits. For the present purpose it is obviously most advantageous to have $\mu = +1$, and it is known from Fermat's theorem that $\mu = +1$ is always possible. Moreover, an infinite series of sets of values of x and y exists, each set satisfying the equation $y^2 - mx^2 = +1$. Hence an infinite series of increasingly rapid approximations to the $\sqrt{m}$ is furnished by equation (2).

The paper was discussed by Messrs. WEAD, FARQUHAR, VAN OSTRAND, and HARRIS, particularly with reference to earlier methods.

Mr. W. W. FRASER then presented a communication on *Vectors and quaternions; what has been done and what can be done.* Among his definitions we find that Hamilton has defined the quaternion as the quotient of two vectors α, β, as $q = \frac{\beta}{\alpha}$; and as a set of four, or $q = x + iy_1 + jy_2 + ky_3$ where i, j, and k are algebraic extraordinaries such that $i^2 = j^2 = k^2 = -1$, $ij = k = -ji$, etc., making the quaternion analysis an algebra of sets in which the commutative law for the multiplication of the extraordinaries is thrown out. Grassmann's Ausdehnungslehr differs chiefly from the quaternions in his definition of the product of two vectors, being defined (inner), $A.B = |A||B|\cos(A,B)$; and (outer) $A \times B = n|A||B|\sin(A,B)$ (after Gibbs). The Borali-Forti assumption that $i\times(\ ) \equiv i$ (of Hamilton) $\equiv \sqrt{-1}$ affords a means of uniting the systems of Grassmann, Gibbs, and Hamilton, since we can effect translations from scalars, rotations with complexes or quaternions, and projective transformations with the dyadic of Gibbs. If Ohm's law for alternating currents is expressed with Grassmann vectors instead of complexes, as used by Dr. Steinmetz, the difficulties of the latter's symbolic method are avoided.

Mr. W. J. SPILLMAN then presented the results of an investigation in collaboration with Messrs. H. R. TOLLEY, and W. G. REED on *A gra-*

[1] Equation (2) may be derived from (1) by writing $a = \frac{y}{x}$ and $b = \frac{mx}{y}$.

phic method for the determination of the average interval between departures from the mean greater than a given departure. In determining the absolute winter minimum below which the winter temperature would not fall on the average oftener than once in thirty years, a problem which arose in connection with the investigations of the methods and cost of heating greenhouses, a curve was constructed for which the abscissas are departures from the mean expressed in terms of the standard deviation, and the ordinates represent the reciprocals of the probability of departures greater than a given amount. Thus if the departure in question is an annual event, the ordinates of the curve represent the average interval, in years, between successive occurrences of the event. Periods of observations of meteorological phenomena are too brief to give very reliable results from the method outlined. The method is also applicable only to variables represented by normal frequency curves. In the case of 569 stations the actual number of spring frosts after the calculated date beyond which frost should occur on the average only one year in ten gave no unexpected frosts in 73 per cent of the stations and only one unexpected frost in 21 per cent of the stations. Thus in 94 per cent of the stations there was either no unexpected frost or only one. The mean of the standard deviation for these stations was calculated from an average of about 23 observations.

The paper was discussed by Messrs. WOODWARD and HUMPHREYS.

The 772d meeting was held on Thursday, April 20, 1916, at the Cosmos Club; President BRIGGS in the chair, 130 persons present.

The evening was devoted to an address by Dr. R. A. MILLIKAN on *Some recent aspects of the radiation problem.* Partly as the result of an experimental situation and partly because of a theory, Planck's h first made its appearance in 1900 in connection with the development of the laws of black-body radiation. Since then it has unexpectedly revealed itself (2) in the domain of specific heats, (3) in that of corpuscular emission under the influence of light and X-rays, (4) in the domain of spectroscopy, both of light and of X-rays, and (5) in the general radiation which is stimulated by the impact of corpuscles against the atoms of matter.

This is an extraordinary experimental situation which has not yet been interpreted in the light of any consistent theory. After the presentation of the facts which have recently come to light in connection with the last three of the foregoing fields, it was pointed out that the work of Duane, Hunt, and Hull seems to permit of a real advance in theory in that it appears to show that the h which is found in connection with the general X-ray radiation, and presumably in connection with black-body radiation has nothing to do with the *natural periods* of the atomic constituents of the radiating bodies as heretofore assumed, since it is quite independent of the *nature* of these bodies. It appears to be rather a property of the ether pulse which is generated by the stopping of an electron.

The inverse problem, namely, that of obtaining any satisfactory conception of the way in which a train of ether waves of frequency ν can eject an electron from an atom with an energy $h\nu$ is as yet quite unsolved. Yet the direction in which a solution must be found seems to be indicated. For the conception of localized bundles of energy traveling out through space from the radiating body is untenable in view of the oil-drop experiment, while energy considerations preclude the possibility that the ejected electron receives its energy from a single spreading ether pulse. It seems therefore necessary to assume with Planck and Bohr that the atom possesses such a structure that it can absorb energy without radiating at all until a critical energy content is reached when an explosion takes place and the electron is ejected with the energy $h\nu$. How it can do this we do not yet know, but experiments are presented which show that in any case this type of absorption is not a phenomenon of resonance. With Bohr's atom, however, which is shown to have had notable success very recently in explaining the relations between the lines of fluorescent X-radiations, it is not surprising that absorption is unlike anything which we have observed in the region of low frequency vibrations where the cause of absorption is, in general, resonance.

The communication was discussed at length by Messrs. DUANE, HULL, BATEMAN, and SWANN. MR. HULL gave some additional experimental data extending Bohr's theory.

A vote of thanks was unanimously extended to Dr. MILLIKAN and the other speakers for their kindness in addressing the Society.

J. A. FLEMING, *Secretary.*

THE CHEMICAL SOCIETY

The 251st meeting of the society was held at the Bieber Building on October 14, 1915, the society being the guests of the members of the Bureau of Chemistry. Several reels of motion pictures showing various activities of the Department of Agriculture were shown. President ALSBERG, as Chief of the Bureau of Chemistry, gave a short address of welcome, outlining the various phases of the work of the Bureau. The laboratories of the Bureau were opened for inspection and a very profitable and enjoyable evening was spent by the two hundred members and guests attending.

The 252d meeting was held at the Cosmos Club on November 11, 1915, for the annual election of officers. President C. H. HERTY of the American Chemical Society was present as a guest of the local section and gave a brief address, especially emphasizing the important rôle the American chemist is to play in the important matters now before the American public.

The following were elected officers for the year 1916:

President: R. B. SOSMAN, Geophysical Laboratory.

First Vice-President: H. M. LOOMIS, Bureau of Chemistry.

Second Vice-President: A. SEIDELL, Hygienic Laboratory.

Secretary: E. C. McKELVY, Bureau of Standards.
Treasurer: F. P. DEWEY, Bureau of the Mint.
Councilors: J. JOHNSTON, Geophysical Laboratory; R. C. WELLS, Geological Survey; C. S. HUDSON, Bureau of Chemistry.
Executive Committee: J. C. HOSTETTER, Geophysical Laboratory; E. C. SCHOREY, Bureau of Soils; A. N. FINN, Bureau of Standards; M. J. INGLE, Bureau of Chemistry.

It was the sentiment of the meeting that the previous custom of having a presidential address by the retiring president be revived for the January meeting and for the following years.

The 253d meeting, a special meeting of the society held jointly with visiting members of the Association of Official Agricultural Chemists, was held through the courtesy of the Borden Condensed Milk Company of New York City at the Circle Theatre, November 16, 1915. The program consisted of motion pictures, illustrating the production and testing of certified milk, ably explained by Mr. W. E. B. KIRK, a representative of the company. After the pictures were shown the members adjourned to the research laboratories of the National Canner's Association, 1739 H Street, N.W., for inspection of the laboratories and a social hour.

The 254th meeting (special) was held at the New Willard Hotel on December 8, 1915, the society being guest of the National Rivers and Harbors Congress. The part of the program of especial interest to the members consisted of motion pictures provided by the National Tube Co., showing the manufacture of steel tubing from the ore to the finished product. Explanatory remarks and a short history of the use and manufacture of steel pipes were given by a representative of the company.

The 255th meeting was held at the Cosmos Club on December 16, 1915. R. B. SOSMAN was elected to represent the society as a vice president of the Washington Academy of Sciences during the year 1916. The president appointed the following committee of three to consider the arguments pro and con and present a report to the society regarding the bill H. R. 528, introduced by Representative Albert Johnson of Washington State, to discontinue the use of the Fahrenheit scale of temperature in government publications: W. F. HILLEBRAND, J. JOHNSTON and E. B. SOSMAN. The following were appointed as auditing committee: A. B. ADAMS, J. A. LECLERC, and R. C. WELLS. The following papers were presented.

R. B. DOLE, Geological Survey: *The action of natural waters on boilers.*

B. MCCOLLUM and K. H. LOGAN, Bureau of Standards (given by Mr. Logan): *Chemical factors affecting electrolytic corrosion in soils and reinforced concrete.*

Experiments on corrosion in soils from various sources show a wide variation in the coefficient of corrosion. The rates of electrolytic corrosion were not materially different for Ingot iron, wrought iron, cast iron, and machine steel.

A series of tests in which nitrates, carbonates, sulphates, chlorides, and chromates were added to the soil showed that only the chromates retarded the electrolytic corrosion. The character of the corroded surface depends upon the chemical in the soil. Pitting is not due entirely to the non-homogeneity of the anode.

The coefficient of corrosion in normal concrete is usually about 1 per cent. High current density, temperatures above 50°C., the addition of salt to the cement, and the exposure of small green specimens to CO_2 greatly accelerate the corrosion.

Electrolytic corrosions with alternating currents show low coefficients of corrosion, unless the length of the cycle or the character of the soil is such as to prevent the corroded iron from plating back on the reversal of the current. The coefficient of corrosion is usually low, even when the period of a complete cycle is several hours.

On account of the reversing polarity of the underground structures throughout a large part of the areas affected by stray currents from street railways, electrolytic damage will usually be much less than might be expected.

Coefficients of corrosion greater than 100 per cent are only found when the current density is low, and are probably due to accelerated self-corrosion. (Author's abstract.)

G. K. Burgess and P. D. Merica, Bureau of Standards (given by Mr. Merica): *Some examples of metal failures.* The talk was illustrated by many slides of great interest.

The question of metal failures is a very comprehensive one and may indeed be said to embrace all cases in which a metal does not fulfill, as well as may be, the use or uses to which it is put. Whether or not a metal is a failure under given conditions may therefore be a relative matter and there cannot usually be an ideal standard of service.

Metal failures may evidently be classified as to type or cause, whether due to inherent chemical or physical imperfections or to some incorrect treatment (thermal, mechanical or chemical) which it may have received either in manufacture or subsequently.

It is often necessary, in considering metal failures, to fix the responsibility for failure, and it may be necessary at times to decide whether the fault lay in the metal or in the specifications which may have been so incorrectly or inadequately drawn as to be entirely unsuited to the metal in question.

Examples of metal failures and of imperfections in metals were given with illustrations, the same being taken from the experience at the Bureau of Standards.

The effect of pipe, segregation, and blowholes in ingots of steel can be readily traced in the properties of articles manufactured from these ingots. Steel rails, for instance, will contain longitudinal seams, due

to cavities in the ingot, and will be found to be unduly brittle in the web, due to the segregation of the impurities and carbon in the original ingot.

The effect of wrong heat treatment of otherwise good material, such, for instance, as overheating, was illustrated in the case of steel and of naval brass.

Other cases of failure of a typical sort are the oxidation of the tin fillings of fusible tin boiler plugs, due to the presence in the tin of a small content of zinc, the selective corrosion of Muntz metal sheet exposed to action of sea water, and the season-cracking of brass, particularly manganese bronze, which is due to the presence in the material, particularly when in the wrought condition, of high initial stresses. (Author's abstract.)

The 256th meeting, a joint meeting with the Washington Academy was held at the Cosmos Club, January 13, 1916, The retiring president, C. L. ALSBERG of the Bureau of Chemistry presented as his presidential address, *The chemical analysis of nutrition*, which consisted of a brief survey of the advance during the last decade in our knowledge regarding the chemical substances involved in animal nutrition and metabolism. Particular reference was made to the advance in our knowledge of the chemical nature of the active constituents of the ductless gland secretions. The effect of vitamines and small quantities of other materials upon the assimilation of foods was considered. The address called forth considerable interesting discussion. A. SEIDELL spoke of his success in concentrating vitamines by means of Lloyd's reagent, that is, by absorbing with hydrated aluminium silicate.

The reports of the officers for the year 1915 were read and approved. The following committees were appointed by the president for the year 1916: *Communications:* E. B. PHELPS, H. S. BAILEY, W. H. KEEN, R. S. MCBRIDE and A. SEIDELL; *Entertainment:* F. A. WERTZ, H. R. MCMILLIN, G. W. MOREY, H. J. MORGAN, E. E. SMITH.

The following resolution regarding H. R. Bill 528 to discontinue the use of the Fahrenheit thermometer scale in government publications, presented by the committee appointed to prepare an expression of the feeling of the society, was approved:

Resolved, That the Chemical Society of Washington favors unqualifiedly the purpose of Bill 528, now before the House of Representatives and in charge of the Committee on Coinage, Weights and Measures, and endorses said bill, provided it shall appear that its provisions are such as will lead to the desired end with the least determinable inconvenience to the public and to the Government service.

The 257th meeting of the society was held at the Cosmos Club, February 18, 1916. Mr. H. C. FULLER presented a memorandum in relation to the Sheppard bill (S 1082) now pending before the Senate. The substance of the memorandum was adopted with the proviso that a committee of three be appointed by the President to shorten the

memorandum in order to make it more effective. Messrs. JOHNSTON, MUNROE and FULLER were appointed members of the Committee. The resolution in its final form reads;

Whereas the bill now before the Senate, known as S 1082, introduced by Senator Sheppard, which is concerned with the manufacture and sale of alcoholic liquors within the District of Columbia, in its present form contains provisions which would prohibit absolutely the use of grain alcohol for all chemical and technical purposes in all the many laboratories, connected with Government departments or with educational or private institutions, now established in the District of Columbia, and would also prohibit the delivery, for analysis or other purposes, of samples and specimens containing alcohol;

And whereas the important work, highly beneficial to the public welfare, carried on by these several laboratories would be very seriously crippled, and much of it would be stopped altogether, by the prohibition of the delivery of alcohol to these laboratories, or of its use therein; for in many chemical operations pure alcohol is an absolute necessity and irreplaceable;

And whereas Congress itself has specifically provided in the Food and Drugs Act and in the Insecticide Act that the degree of purity of food and drug products should be determined by certain prescribed tests, few of which could be made if the use of alcohol be prohibited;

And whereas it is unreasonable to suppose that Congress would enact a law which would effectually prevent the making of tests prescribed in previous acts, work which moreover can not be interrupted without detriment to public welfare; and it is the belief of this Society that it is not the intent of Congress to prevent legitimate and necessary scientific work in any laboratory, private or public, or to hinder the advancement of science, or to interfere in any way with the training of technically skilled men, especially at this time when the advantage—nay, the necessity—of proper technical training and advice has been brought home to all of us;

Therefore be it resolved by the Washington Section of the American Chemical Society, that the foregoing summary statement of facts be brought to the attention of those in charge of this bill, with the plea that they modify those provisions which, if the bill S 1082 were enacted in its present form, would be highly prejudicial to the laboratory work, scientific, technical, and educational, now carried on within the District of Columbia, a work which is absolutely essential to the continued progress of the country.

The program of the evening consisted of a lecture on *Radium* by C. L. PARSONS, of the Bureau of Mines. A concise survey of the recent methods developed by this Bureau for the extraction of radium from carnotite ores was accompanied by lantern slides and motion pictures showing the entire range of operations from the mining of the ore to the crystallization of the radium bromide. By means of the new methods it is thought that 90 per cent of the radium is actually

recovered; by previous methods about 70 per cent was considered a very good yield. An interesting discussion ensued, partaken in by many members of the society.

The 258th meeting of the society was held in the Assembly Hall of the Y. M. C. A. on March 9, 1916. The following program was presented:

H. H. CUSTIS, Bureau of Animal Industry: *The action of light on chlorine, with special reference to the formation of chloracetic acid.*

The reactions between chlorine and other substances in the presence of light were all classed with those reactions in which the light only gives an impulse to the activity of chemical change. Several examples of such reactions were cited. A brief outline of the history of the study of phenomena accompanying reaction between hydrogen and chlorine in the presence of light and a résumé of the work previously reported on the reaction between chlorine and acetic acid were given.

The speaker then reported that after unsuccessful attempts to chlorinate acetic acid, benzene, and toluene under the influence of light from a projection lantern he was able to make mono-chloracetic acid by the action of chlorine on acetic acid at the temperature of the steam bath under the influence of the rays from an iron arc. The reaction was accelerated by the use of red phosphorus as catalyzer. He was also able to chlorinate benzene and toluene at room temperature, using an iron arc. In these experiments no catalyzers were used. Though benzene was not chlorinated by chlorine subjected to the rays from a quartz mercury arc while passing through a quartz tube, toluene was chlorinated. (Author's abstract.)

ATHERTON SEIDELL, Hygienic Laboratory: *The isolation of vitamine from brewer's yeast.*

Vitamine is the name which has been given to a recently recognized essential food element necessary for normal metabolism. Although vitamine (vitamines?) is undoubtedly widely distributed in food stuffs, the amount actually present in any one is probably very minute. Attempts which have so far been made to concentrate vitamine or isolate it have been only partially successful. The material appears to be destroyed or seriously altered by the manipulations involved in the processes of isolation. It has therefore not been possible to make extensive studies of the physiological action of vitamine uninfluenced by accompanying substances.

Brewer's yeast has been shown to be comparatively rich in vitamine. While attempting to concentrate the vitamine present in this product it was ascertained that hydrous aluminium silicate (fuller's earth) selectively adsorbs vitamine from the complex, aqueous, autolyzed yeast solution. Experiments on pigeons receiving a deficient diet of polished rice showed that the separation of the vitamine by means of the adsorbent was complete. The yeast solution filtered from the

solid was free of vitamine, whereas the solid adsorbent retained all that was originally present in the yeast solution. The solid combination of fuller's earth and vitamine appears to be stable and shows unimpaired vitamine activity even after several months. Since the inorganic solid adsorbent is an inert substance, from the standpoint of its action on the organism, the combination serves as a convenient source of vitamine for nutritional experiments and possibly as a therapeutic agent in the treatment of beri-beri and other nutritional deficiency diseases. Experiments upon the separation of vitamine from its solid combination with fuller's earth are under way and a crystalline product possessing the vitamine action has already been prepared. (Author's abstract.)

R. R. WILLIAMS, Bureau of Chemistry: *The chemical nature of the vitamines.*

Alpha-hydroxypyridine exists in three isomeric forms. Two of these forms can be isolated as needle and prism crystals respectively, while the third enolic form is present only in the metallic salts of the compound. Prism crystals may be converted into needles by dry heat. The needles on standing in the air at ordinary temperatures are transformed again into prisms. Water solutions of the needles produce rapid cures of avian beri-beri when administered within five or six days after the solution is made. The prism crystals have no curative power. The enolic or metallic salt form probably possesses no therapeutic value. A similar isomerism and physiological effect appears to be common to all hydroxypyridines, suggesting that the natural vitamines possess a similar chemical structure. (Author's abstract.)

The 259th meeting (special) of the society was held in the Chemical Lecture Hall of George Washington Medical School on March 21, 1916. The speaker of the evening, JOHN URI LLOYD, of Cincinnati, presented a *Practical demonstration of some of the principles of colloidal chemistry.* An experimental demonstration was given of the selective absorption of alkaloids by what is now known as Lloyd's reagent, a selected fuller's earth (hydrated aluminium silicate) especially treated to give extreme fineness of grain and great absorptive power. The absorption is carried out in acid solution and presents a distinct advance in the technique of alkaloid separation and manufacture. The action is extremely rapid and applies to practically all alkaloids. However, though the application of the reagent as an absorbent for alkaloids used in the therapeutics looks promising, its application as a remedy in alkaloid poisoning has so far been unsuccessful, owing to the liberation of the alkaloid in the alkaline parts of the alimentary tract. A considerable number of slides were presented showing micrographs of the reagent and its absorption compounds.

E. C. MCKELVY, *Secretary.*

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 307th meeting was held in the lecture room of the Cosmos Club on March 22, 1916.

INFORMAL COMMUNICATIONS

E. T. WHERRY presented a communication on the cavities in vein fillings of the basalt near Paterson, New Jersey. He showed that the lozenge-shaped cavities from a shale in eastern Pennsylvania were like those in the basalt. These cavities correspond to glauberite crystals. (Published in full in Journ. Wash. Acad. Sci. **6**: 181–184. 1916.)

REGULAR PROGRAM

R. B. SOSMAN and J. C. HOSTETTER: *Zonal growth in hematite and its bearing on the origin of certain iron ores.*

In studying the natural oxides of iron, the authors have observed that some of these can be separated magnetically into fractions. They have also shown (Journ. Amer. Chem. Soc., April, 1916) that ferric oxide (Fe_2O_3) and magnetite (Fe_3O_4) form a series of solid solutions in which the percentage of FeO increases continuously from zero to 31.03, which is the percentage in magnetite. The oxides become increasingly magnetic as the percentage of FeO increases.

The powdered oxide from certain crystals of hematite from Elba contains considerable FeO and can also be fractionated magnetically. It is therefore not homogeneous, as would be the case if the crystal were a uniform solid solution throughout. Analyses and magnetic measurements on a cross-section of an Elba crystal showed that the magnetic susceptibility and percentage of FeO vary, not irregularly, but continuously, being highest at the base and lowest at the free-growing tip of the crystal. The crystal is therefore zoned with respect to its FeO content. The physico-chemical conditions which could bring about such a zonal growth were discussed.

R. W. PACK: *Structural features of the San Joaquin Valley oil fields, California.* (Illustrated.)

The general features governing the occurrence of oil in the San Joaquin Valley are (1) the presence of material in which the oil originated; (2) an avenue affording an easy escape for the oil from this material in which it originated; (3) lithologic and structural features that together form a reservoir favorable for the accumulation of this oil.

The first condition is satisfied by the presence of thick formations of shale composed largely of the remains of minute organisms—diatoms and foraminifers—and it appears certain that it is in these formations and from these organisms that the petroleum originated. The escape of the petroleum from these shales is rendered easy by the unconformable relation at the top of the shales. Adequate reservoirs are afforded by the sandy beds that rest upon the truncated edges of

the shale. Numerous anticlines heading in the central part of the ranges on the west side of San Joaquin Valley, running out into and plunging beneath that valley, form traps in which the oil has accumulated and is now retained. Each of the productive fields on the west side of the San Joaquin Valley shows all the features listed and the intervening non-productive areas lack one or more of them.

The sandy beds that form the reservoirs for the oil outcrop in or near the fields. Escape of the oil is prevented by a sealing of these beds by tar. This tar is the result either of the fractional distillation of the oil and removal of the lighter constituents or of interaction of oil and mineral waters, both probably being effective. Oil moving upward through the sandy beds overlying the shales, being prevented by this tarry seal from further movement, moves outward down the dip through sandy beds lying stratigraphically above the bed resting unconformably upon the shale. Oil moves through these upper beds away from the plane of unconformity until its further movement is prevented by a sealing of these upper beds by tar. The tarry seal in this case may be formed, as in the case with the outcrop, by natural fractionation of the oil, but in the deeper sands it is evidently caused chiefly by the action of "edge water" on the oil. The tarrification of oil in the presence of water is well recognized in the fields, and this knowledge is of practical value in drilling for the deeper sands, since it furnishes a guide as to the proximity of water.

The productive sands, although occurring in a definite zone in the lower part of the formation that rests upon the shale, are not continuous sands, but lie rather in a step-like arrangement, one small oil sand above another, all of them abutting against the diatomaceous shale on the flanks of the anticline, but diverging more and more widely from the shale toward the axis of the syncline.

CHARLES T. LUPTON: *Notes on the stratigraphic and structural relations in southern and eastern Bighorn Basin, Wyoming.*

Bighorn Basin is a large topographic and structural depression in northwest Wyoming nearly surrounded by Bighorn, Bridger, Owl Creek, and Shoshone Mountains. It is drained by Bighorn River, which flows through deep canyons in the mountain rim at the south (Wind River Canyon) and at the northeast (Bighorn Canyon).

The rocks exposed in the basin range from Cambrian to Quarternary in age. Only those formations between the Morrison and the base of the Wasatch were considered in detail. Leaves of Cretaceous age were found during the field season of 1915 in the upper part of the Morrison formation near Ten Sleep. The overlying Cloverly formation, Thermopolis and Mowry shale, Frontier formation, Cody shale, Mesaverde formation, Bearpaw (?) shale, Lance (?) and Fort Union formations were described in considerable detail. Of these, the Cloverly, Mowry, and Frontier produce a light, high grade oil and some gas. The Cody shale is equivalent to the upper part of the Colorado and the lower part of the Montana groups. The Mesaverde on the south

and east sides of the basin is believed to correspond to the Gebo on the west side, Bearpaw (?) to part or all of the Meeteetse, and the Lance (?) to the Ilo. No evidence has been obtained in Bighorn Basin to prove that the beds designated Bearpaw (?) or Meeteetse are marine.

Two unconformities are recognized in Bighorn Basin—one at the base of the Fort Union and the other at its top. Discordance in dip and lenses of conglomerate mark the unconformities.

Structurally Bighorn Basin is a vast geosyncline with minor folds developed on its flanks. Its axis trends northwest-southeast. The axes of the minor folds trend in the same general direction but more nearly parallel to the adjacent mountains. The upfolds are characterized by narrow flanks and steep dips on the mountainward sides and broad flanks and gentle dips on the basinward sides.

The anticlines and domes that produce most of the oil and gas are nearest the major axis of the basin. Many of the anticlines plunge into the basin and are of little value as oil and gas reservoirs.

Most of the anticlines are developed in rocks older than Wasatch, but in a few places that formation is deformed. Such a condition suggests a greater deformation of the beds on which the Wasatch rests.

Only a few faults are present. The greater number of them extend parallel to the strike of the beds. An unusual condition obtains at Greybull, where dip faults throw out the middle of the oil and gas field.

CARROLL H. WEGEMANN, *Secretary*.

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 554th regular meeting of the Biological Society of Washington was held at the Cosmos Club, Saturday, April 8, 1916, at 8 p.m.; called to order by President HAY, with 65 persons present.

The President called attention to the recent death of WELLS W. COOKE, Treasurer of the Society, and announced the appointment of Messrs. HOLLISTER, GIDLEY, and WETMORE to draw up appropriate resolutions. The President also announced the election of Dr. NED DEARBORN to the office of Treasurer, made vacant by Mr. Cooke's death, also the appointment of Dr. DEARBORN to the committee on publications.

On recommendation of the Council the following persons were elected to active membership: ROBERT M. LIBBEY, Washington, D.C.; G. K. NOBLE, Museum of Comparative Zoology, Cambridge, Massachusetts; and Dr. HOWARD B. AMES, U. S. Navy (Retired).

The following informal communications were made:

Dr. R. W. SHUFELDT commented upon and exhibited specimens of a Japanese salamander, *Diemictylus pyrrhogaster*, obtained from a local dealer in live animals.

Dr. PAUL BARTSCH called attention to the introduction of the European agate snail, *Rumina decollata*, in certain parts of the southern states and to the recent publication by J. B. HENDERSON of a book

entitled, *The cruise of the Tomas Barrera*, the narrative of a scientific expedition to western Cuba and the Colorados Reefs, with observations on the geology, fauna, and flora of the region.

Dr. M. W. LYON, JR., made remarks on the history of the *Filaria bancrofti* embryos exhibited at the previous meeting of the Society.

Mr. F. KNAB discussed the mosquito host of *Filaria bancrofti*, saying that an appropriate species of Culex is found in Washington in the late summer.

The regular program was an illustrated lecture by Mr. EDMUND HELLER entitled, *Hunting in the Peruvian Andes*. Mr. Heller gave an account of a recent collecting trip made by him from the west coast of Peru up into the high Andes and down to the head waters of the Amazon. He described the animals collected, mainly mammals, but also birds and reptiles, including the rare spectacled bear, wild llamas, etc. He also commented on the habits and customs of the natives, and showed photographic lantern slides not only of the wild life, the inhabitants, and physiographic features, but also of many points of archeologic interest.

M. W. LYON, JR., *Recording Secretary*.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 492d meeting, held December 21, 1915, Dr. J. WALTER FEWKES, of the Bureau of American Ethnology, gave an illustrated lecture on his archeological investigations in the Mesa Verde National Park during the preceding summer. The substance of the address has since been given in this JOURNAL (**6**: 212–221. April 19, 1916), although with a special view to a comparison between the "Sun Temple" excavated by him on the Mesa Verde and the so-called prehistoric "towers."

At the 493d meeting of the Society, held January 18, 1916, Dr. TOM A. WILLIAMS read a paper on *The origin of superstitions*. He stated that the forms which superstitions assume are imposed by traditional survival, but that superstitious feeling occurs when extraneous support is desired in too difficult situations. It is a reaction to inadequacy, especially prone to occur when the brain is numb with drugs, infections, body poisons, or fatigue. An attitude of mind may also induce it. Other refuges from the feeling of inadequacy or discomfort are drug-taking, wine-bibbing, tobacco-smoking, wandering about, various amusements, and even intemperate work. The fantastic personalities of our dreams, of which so-called psychic phenomena are merely a variety, give support to occultistic beliefs.

It is in the feelings themselves, however, that the origin must be sought, belief being merely an attempted rationalization of these, as when a person deduces from the exceptional character of his feelings during the experience a supernatural quality of the force that must have caused it. Such inferences need have no religious color. For

instance, one patient with intact perceptions and intelligence declares, "It is black all around; there is no world there; but you can not understand, and I can not explain it." The root of this condition is a disturbance of the internal feelings, the cause of which is usually a physical disorder, a perverted body chemistry. However, as the feelings may be incited psychogenetically, and as the superstitious belief may persist even when the body chemistry is restored, it is necessary in dealing with them to understand the facts of human psychology, more especially of morbid psychology. The comfort brought by the feeling of support and the sense of refuge found in reliance upon a supernatural agent make their appeal very strong to inadequate persons. That is why the superstitious aspect of so many religions is clung to so fervently; for, not differentiating this from the essence of the religion, the devotee fears that the destruction of the superstition will entail the loss of the comfort brought by his religion, which is, of course, an improper inference.

That the religious aspect of these, however, is not that which makes belief in them so strong is proved by what so often happens during anaesthesia. For instance, Humphry Davy, on waking from nitrous oxide narcosis, had so grandiose a feeling of having made wonderful discoveries that he showed his contempt for those round him by walking about calling, "Nothing exists but thought; the universe is composed of impressions, pleasure, and pain;" and it took him some time to overcome his belief in the validity of this experience. Again, a young man, who, during anaesthesia for an operation, had the awful feeling of a world reverting to nothingness, could not shake off the belief in the terribleness of this, so that special measures had to be used to bring his mind into normal touch with the real world.

The color of the superstition depends upon the *zeitgeist;* but its fundamentals are psychopathological facts, and the study of their origin demands an extensive knowledge of the cognate phenomena revealed by persons with disturbed minds. Even in the case of amputated limbs a patient may declare himself "more sure of the lost limb than of the one he has." Like these instances the inexpressible wonderfulness of the mystic's experience is pure illusion and its origin is in feelings of similar kind.

The portion of the address on *The craving for the supernatural* appeared in the Medical Record for February 12, 1916.

At the 494th meeting of the society, held February 1, 1916, two papers were read. The first, by Dr. TRUMAN MICHELSON, of the Bureau of American Ethnology, was on *Ritualistic origin myths of the Fox Indians.* This has appeared in the Journal of the Washington Academy of Sciences (**6:** 209–211. April 19, 1916). In the discussion, a visitor, Mr. STEWART, who said that he had grown up among the Kickapoo, insisted that scientists should get behind the form of the myth to its meaning and that, although the solar explanation of myths, for example, had been overworked by Max Müller, there is a real esoteric meaning of

the ritual in certain American tribes. Mr. LAFLESCHE agreed, from his knowledge of the Osage ritual, that all has a meaning and that nothing is nonsensical. Every bodily movement even has a symbolic significance; the prayers which the ritual contains are for safety, for health, and to secure offspring, that is, for the welfare of the tribe. Mr. HEWITT cited, in this connection, the Iroquois ritual for the installation of the chief, which recounted the history of the tribe and the formation of the League. Dr. MICHELSON replied that it is necessary to study the forms of rituals of different tribes in order to determine their origins, because it is evident that the interpretations now placed upon them are in nearly all cases secondary. Dr. SWANTON, referring to the old question as to whether myth or ritual were prior, stated as the essential fact that myth and ritual are in association and that these associations as they exist should be the object of our study.

The second paper, by Mr. WILLIAM H. BABCOCK, was entitled *Certain pre-Columbian notices of American aborigines.* It dealt mainly with records found in early Norse writings. Four regions were taken up in geographical order: The eastern coast of Greenland; the western coast of Greenland; Markland (probably Newfoundland), and Wineland and the neighboring regions. For the first he quoted from the Floamanna Saga the account of the attack of Thorgisl on the two "giant women" gathering driftwood; for the second, the statement of Islendingabok concerning the Skrelling relics found by the first Norse settlers, the mention in *Historia Norwegiae* of meetings between Norse hunters and Skrellings in the districts north of the settlements, the narrative of the far northward exploration of 1266 contained in a priest's letter (on which voyage no Eskimo were discovered, only the sites of their habitations), and the account of the two trolls who became servants of a shipmaster visiting Greenland. The account of the Markland captives was given from the Hauksbok version of Eric the Red; both of the accounts of the killing of Thorvald, as they present different views of the natives on the southeastern border of the Gulf of St. Lawrence; and both versions of the intercourse of Karlsefni and his people with the more southerly Wineland natives and the hostilities, which ended both it and the Norse scheme of colonization.

In answer to questions by Dr. ANDERSON, Mr. STEWART, Miss BRETON, Dr. FOLKMAR, and others, Mr. BABCOCK said that he considered it probable that Irish monks reached America before the Norsemen. While some of the Celtic theories are fantastical, it is certain that Irish relics were found by the Norse in Iceland; that Disnil tells of a voyage made by them far beyond that island until they were stopped by the ice; that on such voyages they may have touched America; and that the western region which the Norsemen called Great Ireland, or White Man's Land, was probably a part of our coast. The evidence for a Chinese discovery of America was not considered sufficient to warrant quotations in the paper of the evening. "Fusang" may have been Korea, Japan, or at most the Aleutian Islands, although some of the products reported resemble those of Mexico. There is no positive

evidence for priority of discovery by Basque or Breton fishermen. Corte-Real's voyage to Newfoundland occurred in 1500 A.D. The name Bacalaos applied to this land first appears on maps of a later date. On being asked what degree of reliance is to be placed on the Norse narratives, since they were handed down for a time by oral tradition before they were written down, Mr. Babcock said that the earliest dates of the writings are unknown; that the Erlendsson copy of the Eric the Red manuscript was made before 1334, perhaps about 1320; that the narrative which it contains bears evidence of having been composed in the eleventh century; and that a brief log of Karlsefni's voyage seems to be the kernel of part of the sagas. Certainly all of the details are not to be relied on.

At the 495th meeting, held February 15, 1916, Mr. PAUL POPENOE addressed the Society on *Progress in the study of human heredity*. He said that man offers by far the most difficult material for the study of heredity and that the number of students who have undertaken to work upon it is small. The Eugenics Record Office, at Cold Spring Harbor, Long Island, New York, is the principal American agency; Dr. ALEXANDER GRAHAM BELL has founded a Genealogical Record Office in Washington for the study of longevity; many anthropologists are contributing to the knowledge of heredity in man; and various physicians and geneticists in colleges are also making contributions. The Galton Laboratory of National Eugenics at the University of London, directed by KARL PEARSON, is the principal agency in England. On the continent of Europe the work is scattered among medical men and anthropologists.

It is now regarded as established that physical and mental traits are inherited with the same intensity and in the same manner. Most of the physical traits thus far studied have been abnormalities and are therefore not of great significance to race betterment; but the study of longevity and disease resistance points the way to important progress in eugenics. The study of mental traits has also dealt largely with abnormal or pathological conditions—feeble-mindedness, insanity, epilepsy, and the like. At present students are showing a tendency to take up the study of positive characters that are of more significance to the progress of the race.

In many cases an attempt has been made to show exactly how a given trait is inherited. Probably a hundred traits have been classed, at one time or another, as "known," but this list is greatly exaggerated. If the evidence for them were critically sifted, the traits of the exact mode of inheritance of which there could be no doubt would be reduced to a group not much larger than the following: Huntington's chorea, brachydactyly, and a white blaze in the hair (dominants); albinism and various rare diseases or pathological conditions (recessives). Some sexlinked characters are also definitely worked out, as one kind of color-blindness, one kind of night-blindness, haemophilia, and a few defects of the eye.

Concerning the heredity of many other traits, such as feeble-mindedness, we have enough knowledge to be of great social value. Most of our knowledge of the general principles of heredity will have to be learned through experimentation with plants and lower animals. Work with them has resulted in the elaboration of the "factorial hypothesis" of heredity, which is accepted by most advanced workers today; it assumes that every transmission of traits is due to the transmission of hypothetical "factors" in the germ-plasm and that each one of these factors influences an indefinitely large number of factors. These hypothetical factors are perhaps to be looked on as chemical reactions, one of which gives rise to another and so on in an unbroken chain during the development and differentiation of the embryo.

The present knowledge of heredity in man is sufficiently ample to form the basis for much sociological action—to guide a program of national eugenics; but it will be a long time before we can confidently give very much advice as to individual marriage matings.

Several speakers in discussing the paper maintained that environment is of more weight than heredity, notwithstanding the geneticists' claim to the contrary. Dr. FOLKMAR suggested that the evolution of man would be more rapid in the distant future than in the past, because it will be the result, in part, of artificial and not, as in the past, merely of natural selection. In the future, "evolution per saltum" will be possible, although it cannot explain the appearance of the Java man or the Neanderthal, or any other race that has evolved in the past.

Following the suggestion that alcoholic drinks hasten the survival of the fit by killing off the unfit, and that Indians are killed off faster than the whites by the use of alcoholic liquors because their race has not been weeded out through centuries of drinking, Dr. ANDERSON and others stated that many American tribes did have alcoholic drinks before the Discovery. Mescal was found in the Southwest, and the chicha, made from corn or bananas, still farther south. Dr. MICHELSON said, however, that alcoholic beverages were known but slightly north of Mexico prior to the Discovery.

DANIEL FOLKMAR, *Secretary.*

Vol. 10 No. 1 May 1981